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GB 908059
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(54) Method and apparatus for releasably connecting together two objects

(57) A connector, for interconnecting two elements which fit one within the other, such as inner and outer tubes in a subsea oil installation, comprises an annular snap spring (56) carried by the inner element (13) and capable of snapping into an annular groove (32) in the outer element (12) as the inner element is urged in one direction into the outer element. The groove (32) is chamfered on one side to cause the snap spring to be compressed by further movement of the inner element in the said direction and locked in its compressed state to enable the inner element to be withdrawn. The inner element is connected to cables to enable it to be hauled into and out of the outer element from a remote location.

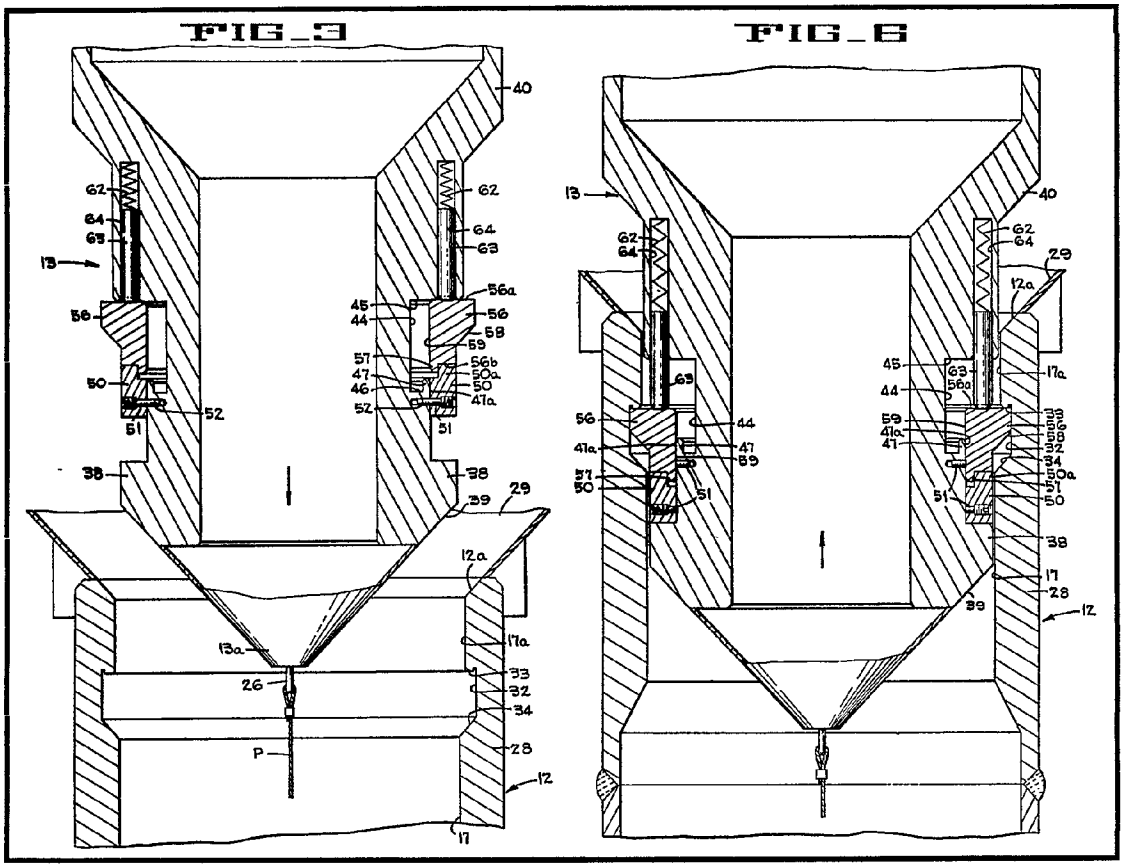

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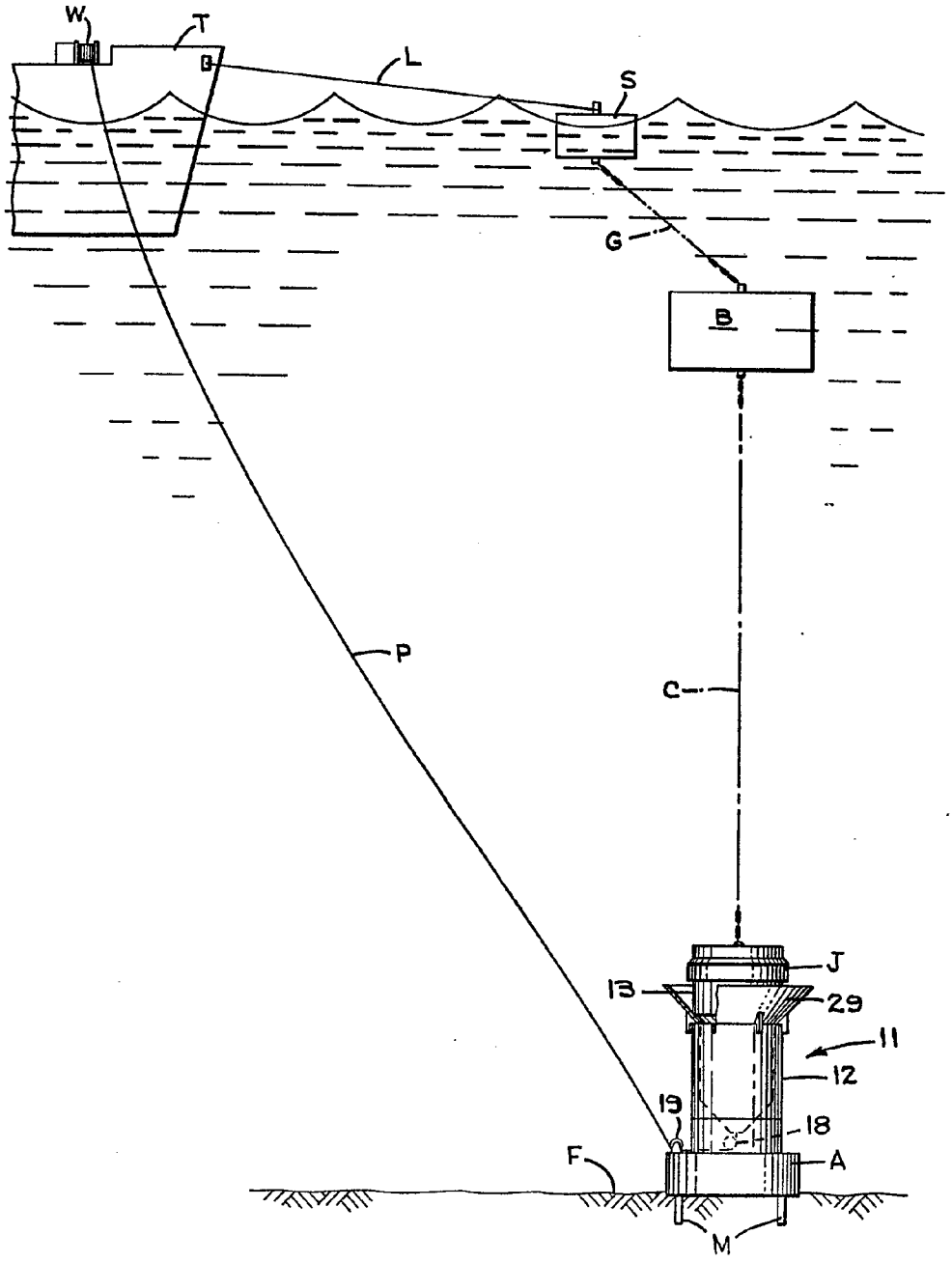
FIG_1



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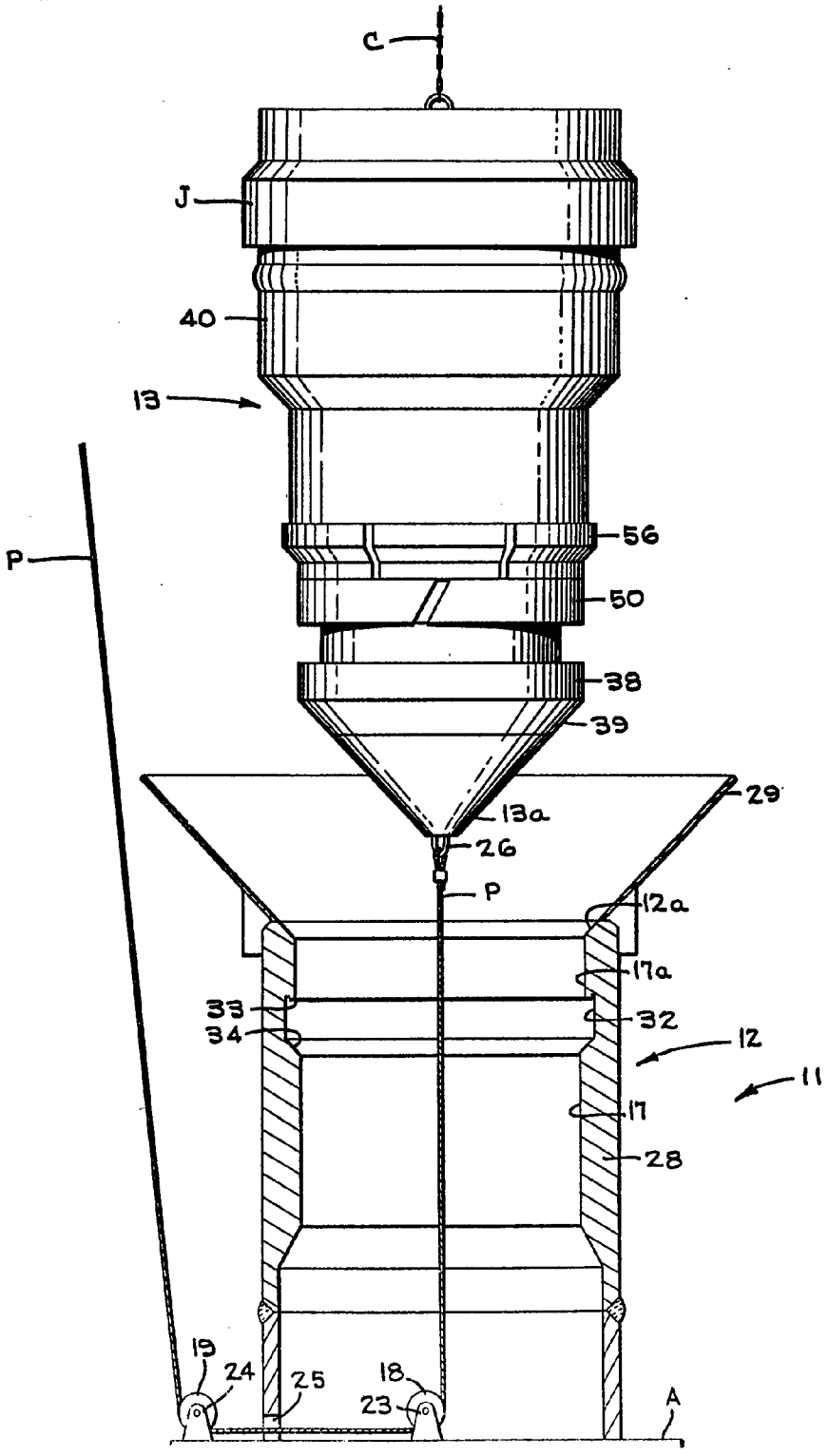
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FIG_3

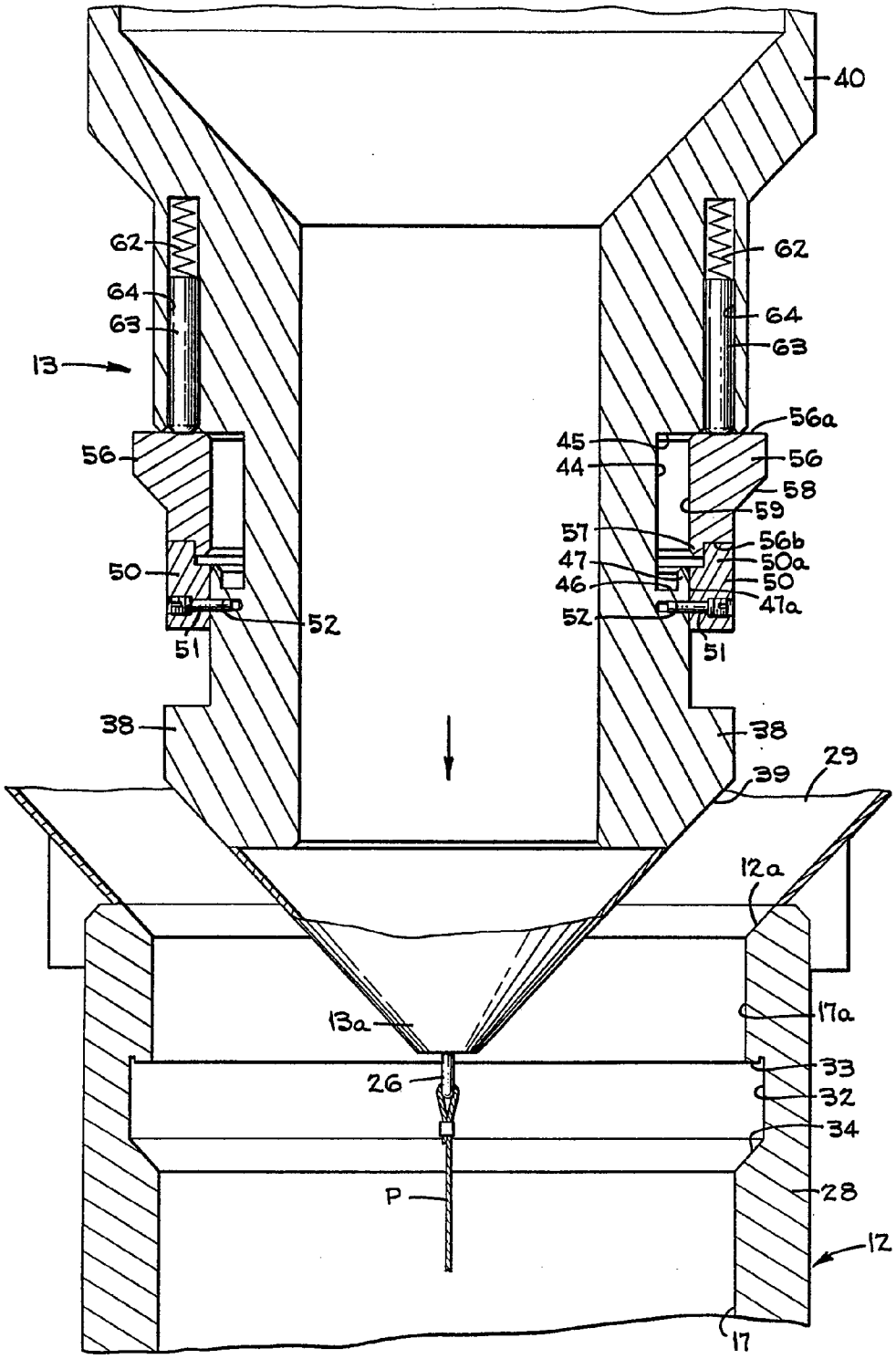
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FIG_4

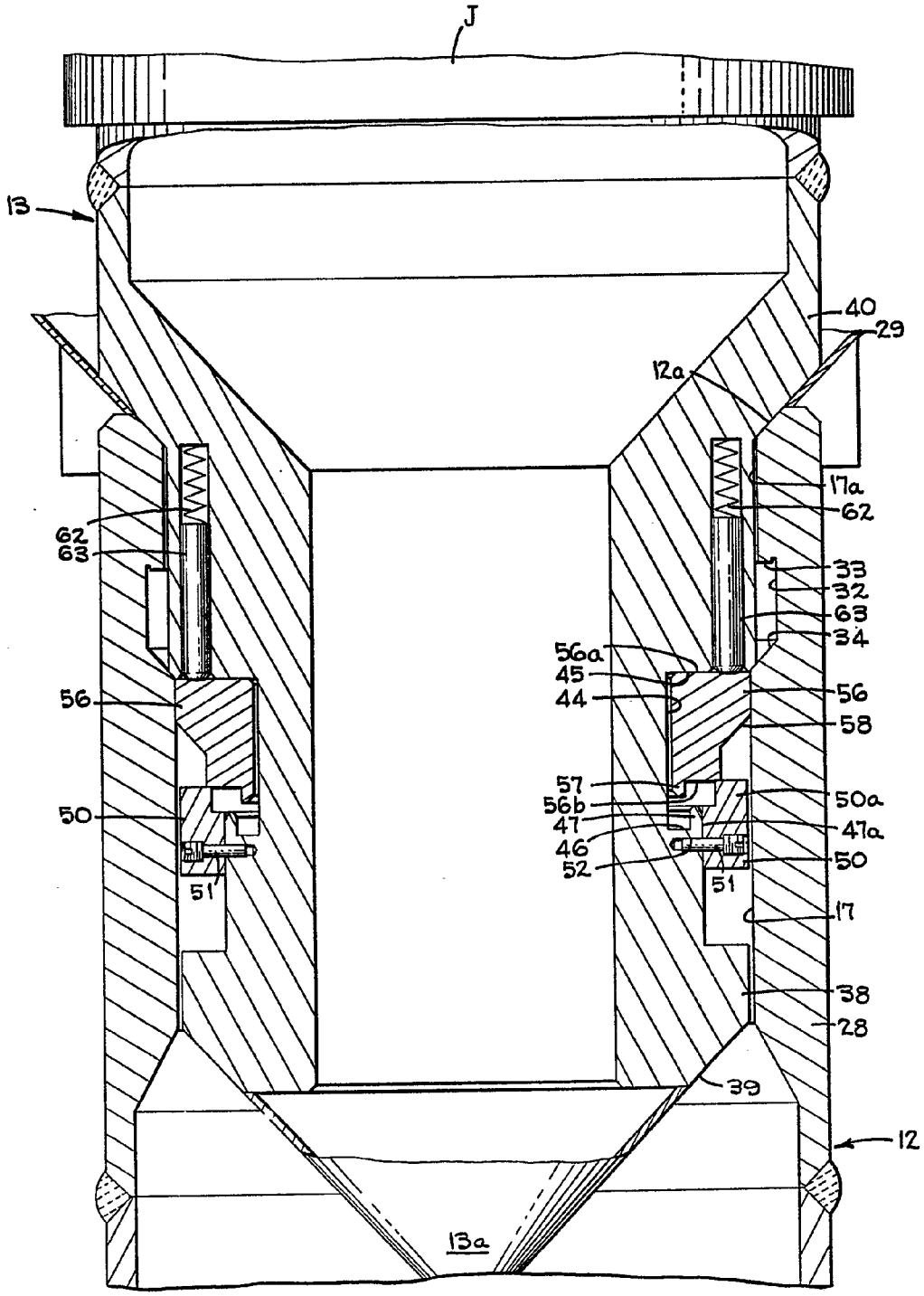
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FIG_5

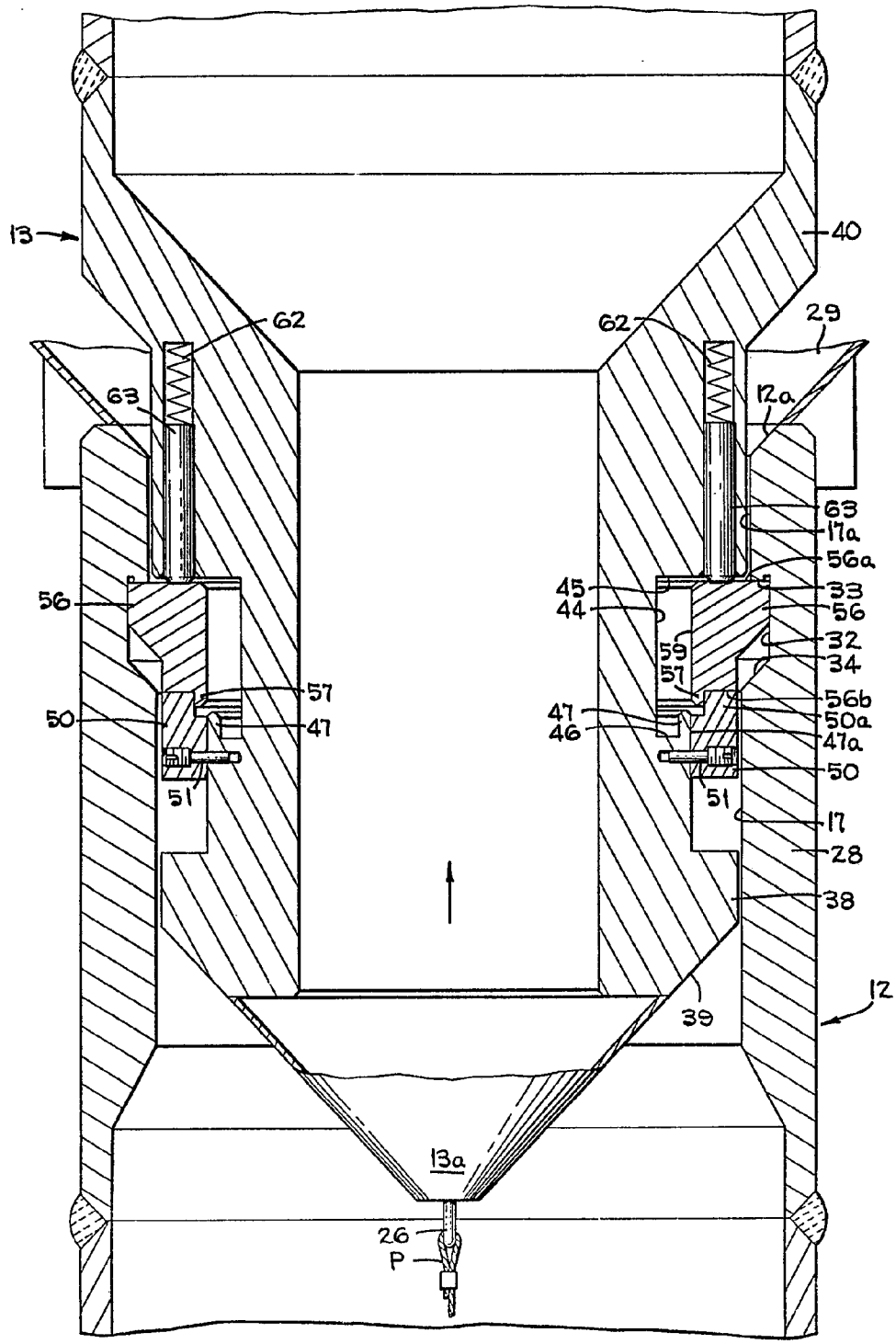
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FIG_6

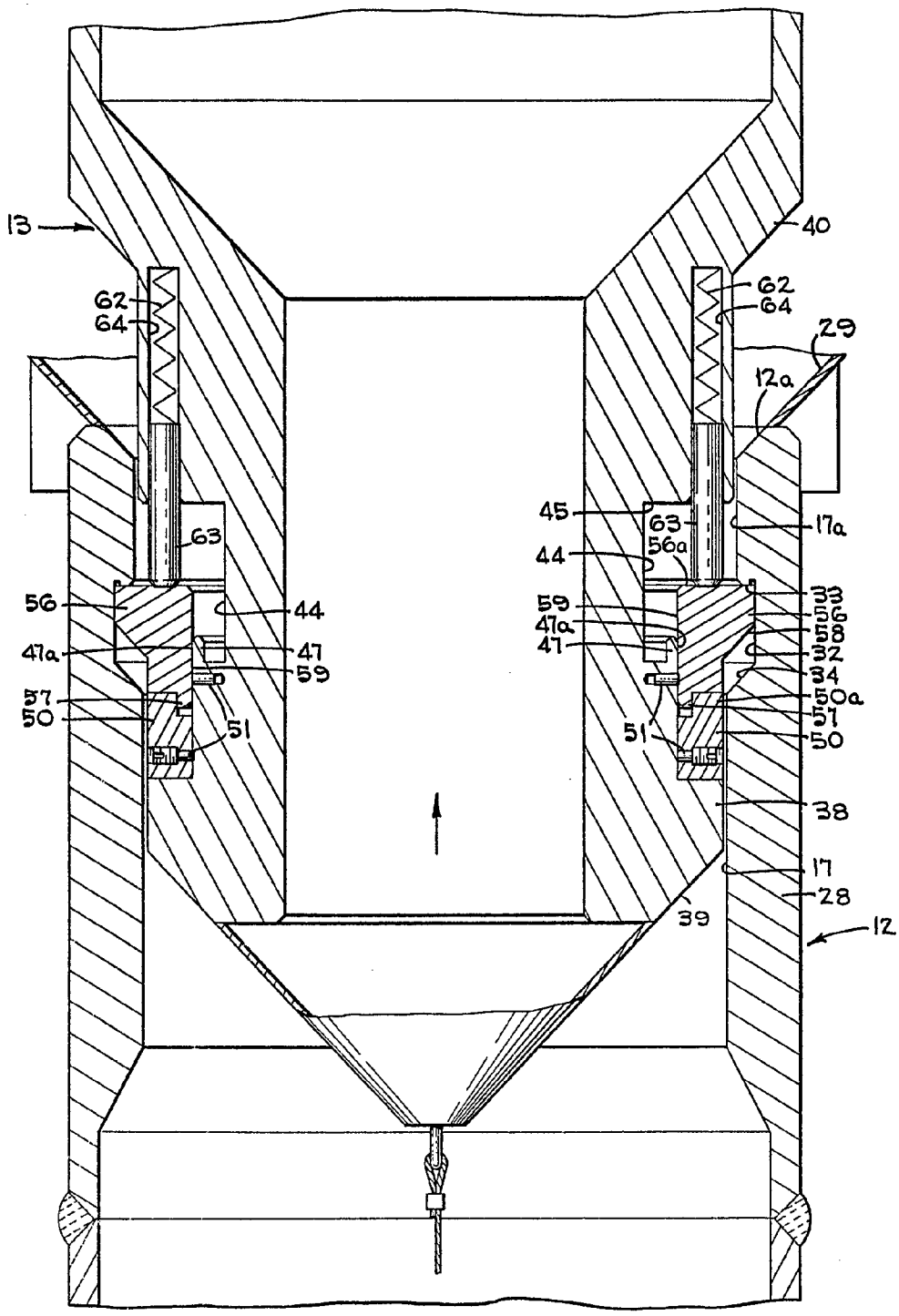
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FIG_7

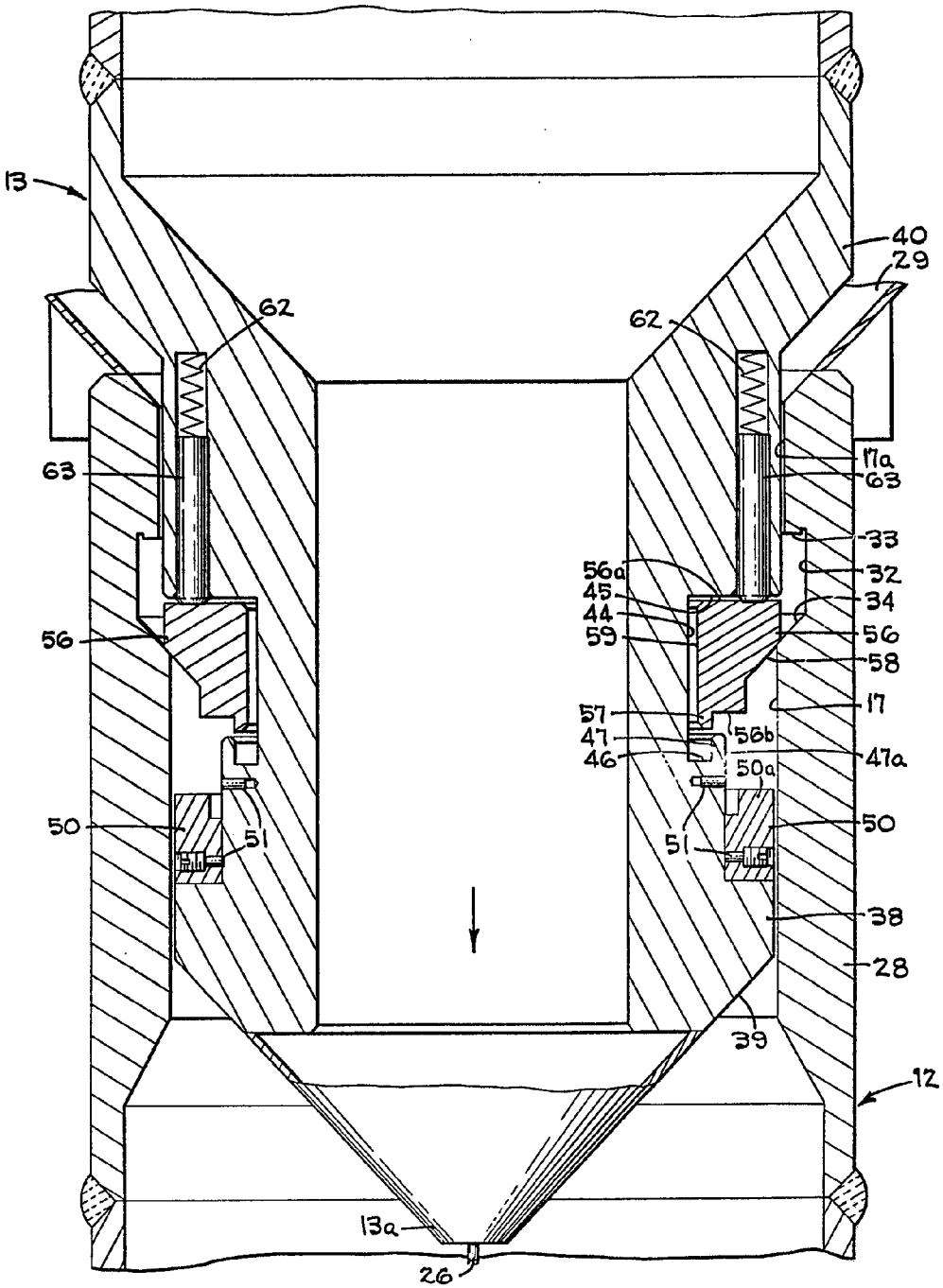
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FIG_8

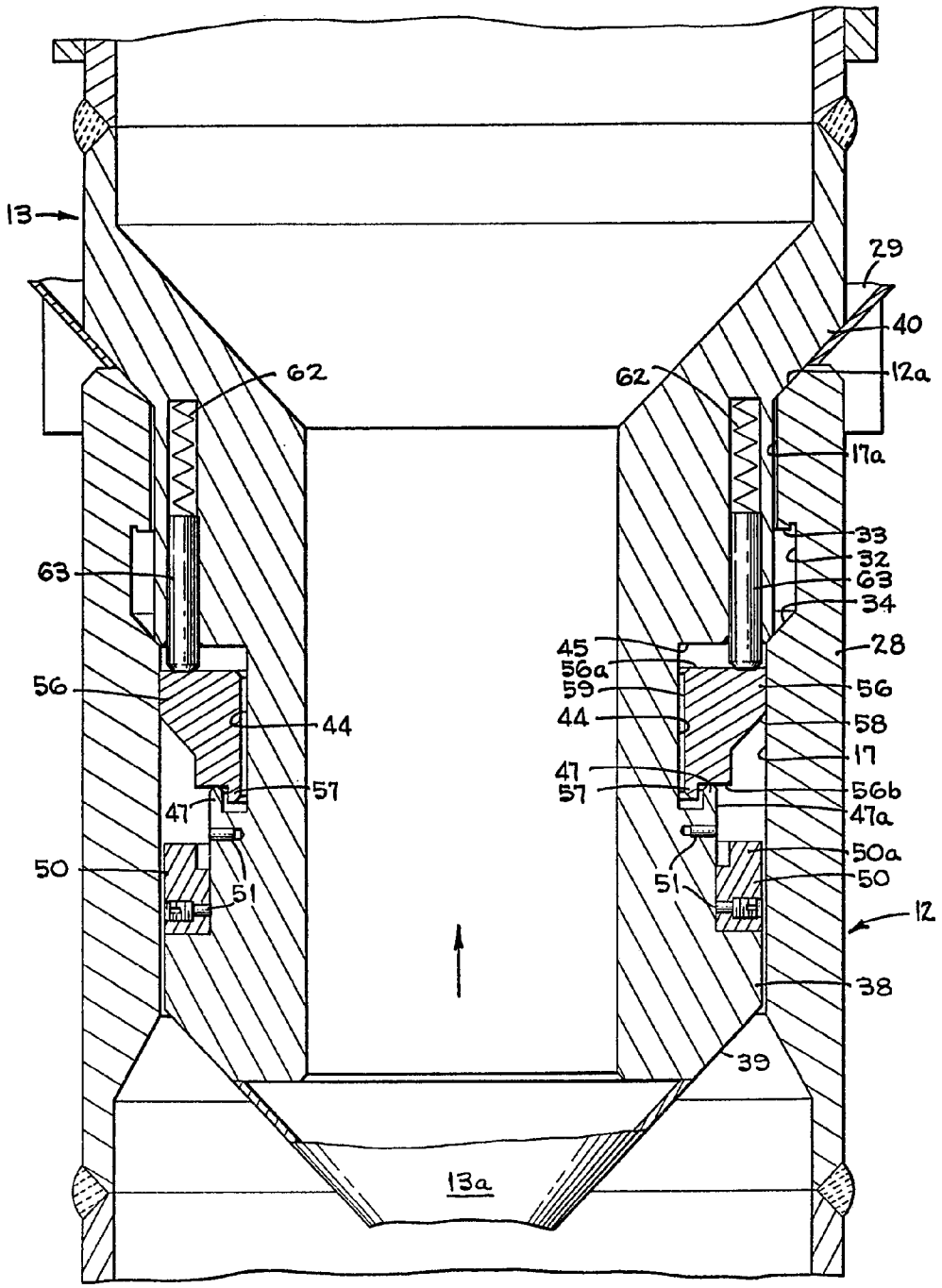
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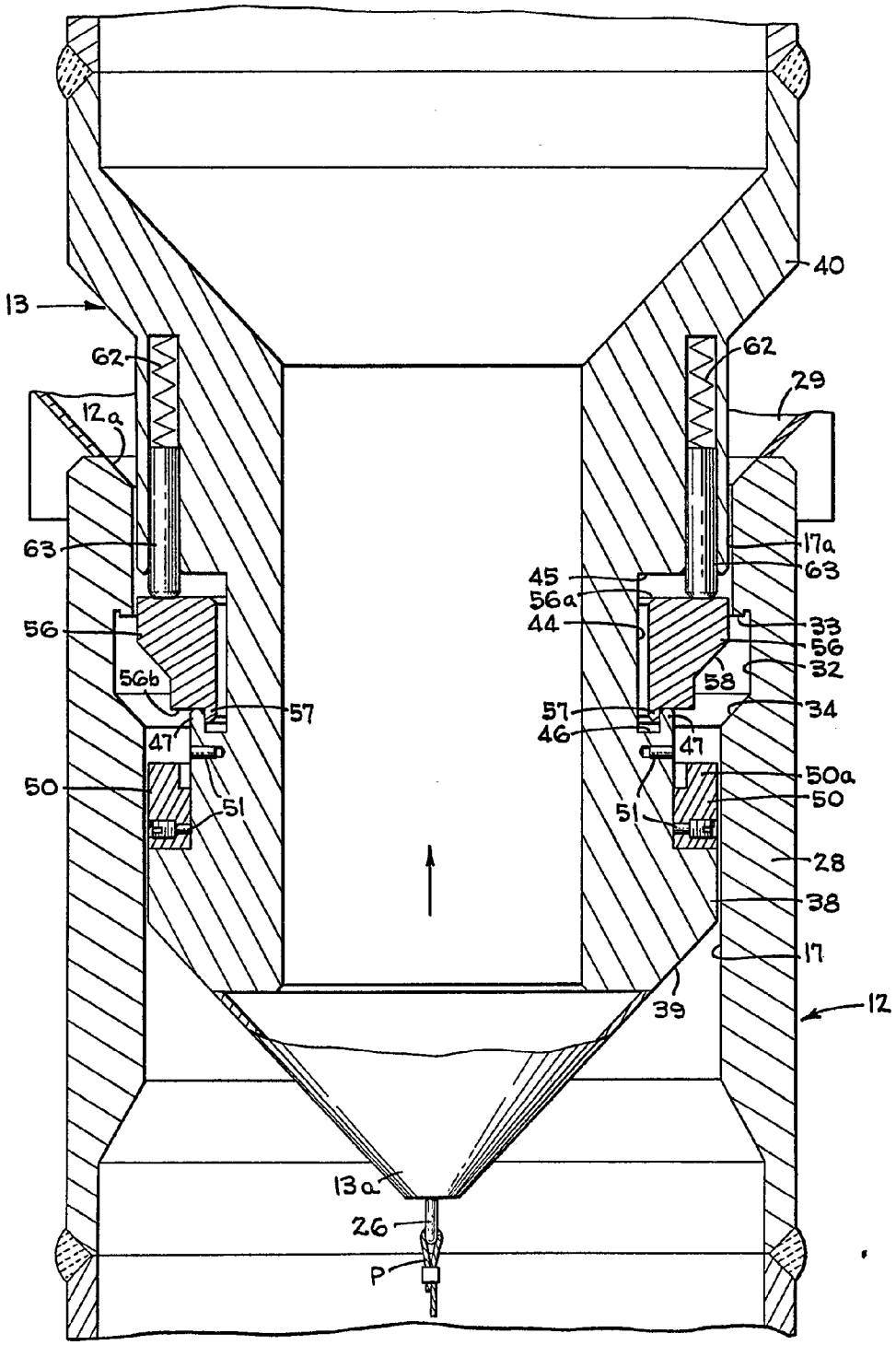
FIG_9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SPECIFICATION

Method and apparatus for releasably connecting together two objects

This invention relates to tubular connectors, and more particularly to tubular connectors for use at underwater or other submerged locations.

The production of oil and gas from offshore wells has grown into a major endeavor of the petroleum industry, and this growth has lead to the development of means for drilling, completing wells and recovering petroleum products from wells in deep-water locations where the use of divers is not practical. This has lead to the need of apparatus for connecting pipes together in deep-water locations and for the installation of mooring facilities for supply boats, marine tankers, etc., all without the use of divers.

The prior art underwater facilities employ connectors which are locked and released either by mechanical or hydraulic manipulation or by rotation of one portion of the connectors relative to the other portions. In deep-water locations the joining together of two portions of a connector by rotation is difficult and often impossible. The locking together of portions of a connector by hydraulic manipulation requires hydraulic lines extending from the ocean surface to the sea floor resulting in unreliable, uneconomical and bulky equipment which is difficult to handle, especially in the deeper subsea locations.

A need exists for an improved connector, and in particular one which is capable of releasably locking together two objects, in which the objects are brought together, locked, subsequently unlocked and therefter separated all by the operation of forces acting along a common axis.

According to the present invention there is provided a system for releasably connecting a marine vessel to an anchor base secured to the sea floor, said system comprising a connector having an inner element and an outer element, said outer element having a passage to receive said inner element, said outer element being secured to said anchor base with said passage in a generally vertical direction, means for connecting said inner element to said marine vessel, means for locking said inner element to said outer element when said inner element is lowered into said passage in said outer element and upward tension is applied to said inner element and means for releasing said inner element from said outer element in response to the release of the upward tension on said inner element.

According to another aspect, the present invention provides a connector for releasably securing two objects together using axial force in one direction to lock two portion of the connector together and using axial force in the opposite direction to unlock the two portions, said connector comprising an outer element having an annular passage defined by the inner surface of said outer element, and having an inner groove extending redially outward from the inner surface of said outer element, an inner element having an annular outer surface to slidably fit inside said passage of said outer element, spring means attached to the outer portion of said inner element, said spring means being biased in a radially outward direction from said inner element, means for compressing said spring means in a radially inward direction to facilitate moving said spring means and said inner element into said passage, said spring means being capable of expansion into said inner groove to lock said inner element to said outer element when force is applied to bias said inner element axially away from said outer element, and means for compressing said spring means in a radially inward direction to release said inner element from said outer element when pressure is applied to bias said inner element axially toward said outer element.

In the accompanying drawings:–

Figure 1 is a diagrammatic view of an offshore mooring system with a tension set, compression release connector embodying the present invention mounted on a subsea base, and with a subsea buoy between the connector and a surface buoy for maintaining tension on the connector;

Figure 2 is an enlarged side elevation, with a portion in section, of the subsea connector of Fig. 1, showing the elements alinged and ready to be interconnected, and

Figures 3–9 are fragmentary vertical sections of the connector elements on a larger scale, showing in sequence the steps for connecting and disconnecting the two connector elements.

An offshore mooring system employing a connector according to the present invention is diagrammatically represented in Fig. 1. This system comprises an anchor base A of concrete or heavy metal secured to the sea floor F by a plurality of anchoring means M, a connector 11 mounted on the base A, a subsea buoy B, a chain or cable C which keeps the buoy B submerged at a distance below the minimum wave trough to insure a steady upward tension on the connector 11, and a surface buoy S connected to the subsea buoy B by a chain G. A tanker or other marine vessel T is secured to the surface buoy S by one or more mooring lines L that permit the tanker to swing freely according to the dictates of wind and current, and yet hold it a proper distance from the buoy for unloading supplies or for other work.

As more easily seen in Fig. 2, the connector 11 includes a female or outer element 12 extending upwardly from the anchor base A, and a male or inner element 13 rotatably

connected to the chain C by a swivel joint J. The outer element 12 is annular in shape and has a central axial cylindrical passage or bore 17 into which the inner element 13 can be pulled by a pull-in cable P. The cable P, which is attached to the nose 13a of the inner element 13 by means of an eye 26, extends around a pair of pulleys 18,19 pivotally mounted on the base A by means of brackets 23,24, and then upwardly to a winch W (Fig. 1) mounted on the tanker T, and a radial port 25 (Fig. 2) provides a passage through the outer element 12 for the cable.

The cable P can be installed around the pulleys 18,19 and through the port 25 when the outer element 12 is fastened in position on the anchor base A, and sonar-activated floats (not shown) can be connected to both ends of the cable for retrieval purposes. The base A, together with the outer element 12, the cable, the pulleys and the floats, is lowered to the sea floor and installed with the floats positioned under water until they are activated by a sonar signal from equipment on the tanker T. The sonar signal causes the floats to move to the surface of the water for removal from the cable, whereupon one end of the cable is connected to the eye 26 on the lower end of the connector's inner element 12, and the other end is connected to the winch W on the tanker T.

The outer element 12 of the connector 11 (Figs. 2–9) has a truncated-cone guide-funnel 29 welded or otherwise rigidly secured to its upper end to facilitate lowering the inner element 13 into the passage 17. In a wall 28 of the element 12 is an annular inner groove 32 with a shoulder-forming radial surface 33 and a lower inwardly-sloping cam surface 34, this groove functioning as a means to lock the inner and outer connector elements together, as will be more fully described later. The upper end of the central passage 17 is enlarged at 17*a* to facilitate connection and disconnection of the outer element 12 to the inner element 13, as does a cam surface 12*a* at the upper end of the element 12.

The lower end of the inner element 13 (Figs. 2–9) includes a radially outwardly extending lower flange 38 having a sloping cam surface 39 at the lower portion thereof to facilitate guiding the lower end of the inner element 13 into the passage 17 of the outer element 12. A radially outwardly extending upper flange 40 at the upper end of the inner element is welded or otherwise secured (Figs. 2, 4) to the swivel joint J. Approximately midway between these flanges is a radially inwardly extending groove 44 (Figs. 3–9) with a shoulder-forming upper radial surface 45, and a lower radial surface 46 terminating in an axially upwardly extending annular lip 47.

An annular shear ring 50, having an axially upwardly extending lip 50*a*, is mounted immediately below the groove 44 by a plurality of shear pins 51 threaded into bores 52 in the body of the inner element 13. An axially-split outwardly-biased annular snap spring 56, having an axially extending lip 57 (Figs. 3–9) on its lower portion and an upwardly and outwardly sloping cam surface 58 on its upper portion, is retained in the groove 44 by means of the lip 50*a* of the shear ring 50. The snap spring 56 is biased downwardly against the shear ring 50 by a plurality of helical springs 62 and positioning pins 63 that are mounted in circumferentially spaced axial bores 64 immediately above the groove 44.

The procedure for connecting the inner element 13 to the outer element 12 and for locking these elements together is sequentially shown in Figs. 3–6. The inner element 13 (Fig. 3) is pulled into position above the passage 17 of the outer element 12 by the pull-in cable P to approximately center the inner element 13 over the outer element 12. The nose 13*a* and the cam surface 39 on the lower end of the inner element are guided by the funnel 29 and the cam surface 12*a* into the passage 17 of the outer element 12 as the inner element 13 is pulled further downward. Further downward movement of the element 13 causes the cam surface 58 of the snap spring 56 to move over the cam surface 12*a* thereby forcing the snap ring 56 into the groove 44 (Fig. 4) as the inner element 13 is pulled all the way into the outer element 12. An upward tension applied to the inner element 13 by the chain C, i.e., tending to separate the elements 12 and 13, moves the element 13 upward until the spring 56 expands into the groove 32 (Fig. 5) to lock the elements 12 and 13 together. Further upward tension on the element 13 forces the shear ring 50 against the spring 56 (Fig. 6) causing the pins 51 to shear and moving the flange 38 upward against the ring 50. The annular lip 47 moves upward causing a cam surface 47*a* on the lip to slide over a cam surface 59 on the snap spring 56 to hold the spring 56 against the radially outward surface of the groove 32. Continued upward tension on the element 13 retains the elements 12 and 13 in the locked position shown in Fig. 6 until the tension is released.

The procedure for disconnecting the two sections of the connector by separating the inner element 13 of the connector from the outer element 12 is sequentially shown in Figs. 7–9. As the inner element 13 is lowered from the locked position of Fig. 6 toward the fully stabbed position of Fig. 8, the snap spring 56 moves downward in the groove 32 (Fig. 7) until the cam surface 58 of the snap spring 56 is pressed against the camsurface 34 of the groove 32. Further downward movement of the inner element 13 presses the shoulder 45 of the groove 44 against an upper edge 56*a* of the sna spring 56 forcing

the cam surface 58 of the spring to move downward and radially inward over the cam surface 34 and moves the snap spring 56 radially inward into the upper portion of groove 44. The helical springs 62 and the positioning pins 63 move the snap spring 56 (Fig. 8) downward until the lower edge 56*b* of the nap spring is against the annular lip 47 of the groove 44 with the radial lip 57 of the snap spring between the lip 47 and the radially inward surface of the groove 44 as shown in Fig. 8.

An upward movement of the inner element 13 into the area adjacent the groove 32 (Fig. 9) and adjacent the inner surface 17*a* allows the snap spring 56 to expand radially outward until the radial lip 57 of the snap spring presses against the lip 47 of the groove 44. The snap spring 56 is held away from the outer surface 17a by the lips 47 and 57 so that the inner element 13 can be moved upward out of the passage 17 of the outer element 12 into the released position.

After the inner element 13 is released it can be raised to the surface (Fig. 1) where the fragments of the shear pins 51 can be removed from the bores 52 in the body of the inner element 13 and from the shear ring 50. The snap spring 56 and the shear ring can be moved into the position shown in Fig. 3 and retained in this position by inserting new shear pins 51. The inner element 13 is ready to be reconnected to the outer element 12.

CLAIMS

1. A system for releasably connecting a marine vessel to an anchor base secured to the sea floor, said system comprising a connector having an inner element and an outer element, said outer element having a passage to receive said inner element, said outer element being secured to said anchor base with said passage in a generally vertical direction, means for connecting said inner element to said marine vessel, means for locking said inner element to said outer element when said inner element is lowered into said passage in said outer element and upward tension is applied to said inner element, and means for releasing said inner element from said outer element in response to the release of the upward tension on said inner element.

2. A system as claimed in claim 1 including means for providing a substantially constant upward tension on said inner element to retain the inner and outer elements in a locked position.

3. A system as claimed in claim 2 wherein said tension means include a floatable buoy and a chain connected between said buoy and said inner element, said chain having a length which holds said buoy below the surface of the water to provie an upward tension on said inner element in spite of wave action.

4. A connector for releasably securing two objects together using axial force in one direction to lock two portions of the connector together and using axial force in the opposite direction to unlock the two portions, said connector comprising an outer element having an annular passage defined by the inner surface of said outer element, and having an inner groove extending radially outward from the inner surface of said outer element, an inner element having an annular outer surface to slidably fit inside said passag of said outer element, spring means attached to the outer portion of said inner element, said spring means being biased in a radially outward direction from said inner element, means for compressing said spring means in a radially inward direction to facilitate moving said spring means and said inner element into said passage, said spring means being capable of expansion into said inner groove to lock said inner element to said outer element when force is applied to bias said inner element axialy away from said outer element, and means for compressing said spring means in a radially inward direction to release said inner element from said outer element when pressure is applied to bias said inner element aially toward said outer element .

5. A connector as claimed in claim 4 wherein said inner element includes an annular outer groove extending radially inward from said outer surface of said inner element and means for mounting said spring means in said outer groove of said inner element.

6. A connector as claimed in claim 5 wherein a portion of said spring means is retained in said outer groove of said inner element when said spring means expands into said inner groove of said outer element to thereby lock said inner element to said outer element.

7. A connector as claimed in claim 5 including means for locking said spring means in said outer groove of said inner element when pressure is applied to bias said inner element axially toward said outer element to thereby facilitate the separation of said inner element from said outer element.

8. A connector according to any one of claims 4 to 7 wherein said spring means is an annular snap spring.

9. A connector as claimed in any one of claims 4 to 8 including an annular lip adjacent said outer groove in said inner element, a radially extending lip on said spring means and means for moving said annular lip into engagement with said radial lip when the inner element is urged toward said outer element to hold said spring means away from said inner groove to facilitate the separation of said inner and outer elements.

10. A connector as claimed in claim 9 wherein said means for moving the lips into engagement includes a cam surface on said outer element for moving said spring means

radially inward as said inner element is axially moved against said outer element and means for spring biassing said spring means axially toward said annular lip on said inner element.

11. A method of releasably securing an inner element of a connector to an outer element of a connector at a remote location using axial force in one direction to lock the elements together and axial force in the opposite direction to release one element from the other, said method including the steps of

(1) stabbing said inner element into said outer element,

(2) applying an axial force in one direction, opposite to that in which the inner element entered the outer element to lock said inner element is said outer element,

(3) maintaining said axial force to retain the elements in a locked position,

(4) applying axial force in a direction opposite said one direction to unlock said inner element from said outer element, and

(5) moving said inner element axially out of said outer element in said one direction.

12. A method of releasably securing two objects together using axial force applied through a cable to lock an inner connector element to an outer connector element and using axial force to release the inner element from the outer element, said method including the steps of:

(1) fastening said inner element to a cable,

(2) fastening said outer element to a stationary object,

(3) stabbing said inner element into said outer element,

(4) applying an axial force via said cable in one direction (opposite to that in which the inner element entered the outer element) to lock said inner element to said outer element,

(5) maintaining said axial force to retain the elements in a locked position,

(6) applying axial force in a direction opposite said one direction to unlock said inner element from said outer element, and

(7) moving said inner element axially out of said outer element in said one direction.

13. method of and apparatus for locking together and subsequently releasing two tubular connectors, substantially as hereinbefore described with reference to the accompanying drawings.

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